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PHASE TRANSFORMATIONS AND NONEQUILIBRIUM INTERFACES.(U)
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Dendritic crystal growth, cellular solidification fronts, interfacial instabilities, free-boundary problems, precipitation kinetics, nucleation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes progress in research on phase transformations and nonequilibrium interfaces achieved during the period October 1, 1980 through September 30, 1981. Accomplishments included development of a nonlinear model of dendritic solidification and a new theory of the stability of lamellar eutectic solidification patterns.

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Interim Technical Report to AFOSR

Grant Number [redacted] AFOSR-80-0034

Principal Investigator: J. S. Langer, Physics Department,
Carnegie-Mellon University, Pittsburgh, PA 15213

Title: Phase Transformations and Nonequilibrium Interfaces

Grant Period: October 1, 1980 - September 30, 1981

I. Research Accomplishments

The following is a summary of major research accomplishments during the grant period October 1, 1980 through September 30, 1981. More detailed descriptions may be found in the publications listed in Part II below.

A. Continued development of a theory of dendritic solidification: In collaboration with H. Müller-Krumbhaar, we have studied a new nonlinear model of the mode-selection mechanism in dendritic geometries.

B. Theory of eutectic solidification: We have completed and published the work on linear stability of eutectic solidification patterns, and also have made new progress in our nonlinear stochastic theory of pattern selection in these processes. Ms. V. Datye has participated in this project.

C. Theory of cellular solidification patterns: We have made major progress toward completion of a detailed set of calculations predicting the appearance and stability of cellular solidification fronts in directional solidification of dilute alloys. Mr. R. Mathur has completed his Ph.D. thesis based on work in this area. The project has been continued with participation by Dr. G. Dee.

II. Publications Supported by AFOSR, 1980-1981

Langer, J. S., "Dendritic Solidification of Dilute Solutions," Physicochemical Hydrodynamics 1, 41 (1980).

Langer, J. S., "Instabilities and Pattern Formation in Crystal Growth," Rev. Mod. Phys. 52, 1 (1980).

Smith, J. B. and J. S. Langer, "Numerical Methods in Solidification Theory," Ann. of the New York Academy of Sciences 337, 198 (1980).

Langer, J. S. and A. J. Schwartz, "Kinetics of Nucleation in Near-Critical Fluids," Phys. Rev. A 21, 948 (1980).

Langer, J. S., "Eutectic Solidification and Marginal Stability," Phys. Rev. Lett. 44, 1023 (1980).

Turski, L. A. and J. S. Langer, "Dynamics of a Diffuse Liquid-Vapor Interface," Phys. Rev. A 22, 2189 (1980).

Müller-Krumbhaar, H. and J. S. Langer, "Sidebranching Instabilities in a Two-Dimensional Model of Dendritic Solidification," Acta Metallurgica 29, 145 (1981).

Langer, J. S., "Kinetics of Metastable States," in Systems far from Equilibrium, Proceedings of the Sitges Conference on Statistical Mechanics, June 1980, L. Garrido, Ed., Lecture Notes in Physics, Springer-Verlag 1980, pp 12-47.

Langer, J. S., "Spinodal Decomposition," in Encyclopedia of Materials Science and Engineering.

Datye, V. and J. S. Langer, "Stability of Thin Lamellar Eutectic Growth," Phys. Rev. B 24, 4155 (1981).

Langer, J. S., "Some Considerations of Stability in Solidification of Lamellar Eutectics," Ann. of the New York Acad. of Sci. 373, 179 (1981).

Langer, J. S., "Pattern Formation during Crystal Growth: Theory" in Nonlinear Phenomena at Phase Transitions and Instabilities, T. Riste, ed., Plenum Press.

III. Interactions

Invited lectures presented by J. S. Langer reporting research supported by AFOSR Grant 80-0034, 1980-81.

Kinetics of Phase Separation

University of Tel Aviv, May 25, 1980
International School of Statistical Mechanics, Sitges, Spain
(course of five lectures) June 1980
University of Alberta, Edmonton, Canada, October 22, 1980

Solidification Theory

Brown University, March 10, 1980
City College, New York, March 27, 1980
University of Virginia, March 28, 1980
Temple University, April 7, 1980
University of Illinois, Chicago Circle, April 23, 1980
Weizmann Institute, Israel, May 23, 1980
Hebrew University, Jerusalem, May 27, 1980
Bell Laboratories, July 24, 1980
Institute for Theoretical Physics, Santa Barbara, September 17, 1980
Lawrence Livermore Laboratory, September 18, 1980
University of Alberta, Edmonton, Canada, October 21, 1980
University of Pennsylvania, November 12, 1980
Princeton University, December 4, 1980
Conference on Nonlinear Problems in Science, Rice University, Houston,
February 28, 1981
IFF, KFA Jülich, West Germany, March 27, 1981
NATO Advanced Study Institute, Geilo, Norway (three lectures)
Harvard University, April 24, 1981
Workshop on Nonequilibrium Phenomena, Institute for Theoretical Physics,
Santa Barbara, July 1981 (three lectures)
International Conference on Crystal Growth, San Diego, July 21, 1981